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FOREST PEST MANAGEMENT

BIOLOGICAL EVALUATION R2-95-3

PEST CONDITIONS AT
ASPEN MOUNTAIN SKI RESORT,
ASPEN RANGER DISTRICT,
WHITE RIVER NATIONAL FOREST, COLOR

United States
Department of
Agriculture

Forest Service

Forest Pest Management
Denver, Colorado

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PEST CONDITIONS AT ASPEN MOUNTAIN SKI RESORT, ASPEN RANGER DISTRICT, WHITE RIVER NATIONAL FOREST, COLORADO

by: _____

Peter A. Angwin
Plant Pathologist,
Gunnison Service Center

Approved by: _____

Roy A. Mask
Leader, Gunnison Service Center

_____

Robert D. Averill
Leader, Forest Health Management

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USDA Forest Service
Renewable Resources
Rocky Mountain Region
Gunnison Service Center
216 N. Colorado
Gunnison, Co. 81230

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EXPERIMENT STATION

EXECUTIVE SUMMARY

In response to observations of increased conifer mortality on Aspen Mountain, an extensive survey was carried out to assess the health of the forest stands at Aspen Mountain Ski Area. The survey consisted of two parts: an aerial survey to identify areas with dead and dying trees; and a ground survey to investigate the causes of mortality. Locations of the stands that were surveyed are given in Appendix A.

Symptoms typical of the Armillaria root disease/western balsam bark beetle complex were observed in 33 spruce/fir stands on the mountain. In almost all of the stands, symptoms were restricted to subalpine fir. Positive identification of Armillaria sp., the fungus that causes Armillaria root disease, was made in 20 stands. Dryocoetes confusus, the western balsam bark beetle, was identified in 32 stands. Minor amounts of spruce broom rust (Chrysomyxa arctostaphyli), twig beetle (Pityophthorus sp.), winter drying, animal damage, and mechanical damage by skiers and heavy equipment were also observed.

In general, the pest problems observed at Aspen Mountain are typical of mature, non-managed stands. To minimize the effects of these pests in the future, vegetation management efforts need to concentrate on the gradual replacement of older stands with younger, more vigorous stands. This can be accomplished by the application of a series of thinning and regeneration cuts throughout the mountain. Treatments to address the specific pest situations may be integrated into this overall vegetation improvement effort.

Unless specific steps are taken to address the root disease/bark beetle situation, many additional firs will continue to be lost. Management alternatives to address the complex, as well as other insect and disease situations, are presented for consideration. A combination of management activities is recommended. These include the institution of an annual hazard tree evaluation program and the selective removal and revegetation of root disease/western balsam bark beetle infection centers. Stand-specific recommendations are summarized in Appendix B. Because the removals, regeneration, and replanting will take many years to complete, prioritization of stands to be treated should be based on visual impact. Stands that are highly visible from the restaurants, ski lifts, gondola or surrounding stands should be treated first.

In addition to the above vegetation management recommendations, it is further suggested that opportunities for interpretation be explored and implemented. These efforts will help to gain public understanding and acceptance of the various vegetation management actions as they are being implemented. Recommended interpretive options include the installation of signs where people congregate and/or a series of signs (an interpretive ski run) along one of the more highly-used ski runs. Summertime interpretation may be implemented in connection with hiking and mountain biking activities. In addition, public involvement in replanting efforts may be encouraged. The Forest Health Management Staff of the Gunnison Service Center is available to assist with the interpretive effort.

In order to coordinate the above activities with other land management objectives for the area (aesthetic, recreation, wildlife, and other concerns), the vegetation management plan that is currently being developed needs to be completed as soon as possible. Again, the staff of the Gunnison Service Center is available to assist with this effort.

ACKNOWLEDGEMENTS

Appreciation is extended to Tom Eager, Dave Johnson, and Jeri Lyn Harris for their assistance in the field work and to Renee Brekke for preparing the stand map in Appendix A.

INTRODUCTION

In October 1992, Pete Angwin and Bernie Raimo (Plant Pathologist and Entomologist, Gunnison Service Center) visited the Aspen Ranger District to evaluate the cause of mortality of subalpine fir in the spruce/fir forest stands at Aspen Mountain Ski Resort. While at the ski area, it became apparent that the mortality was due to the disease/insect complex of Armillaria root disease and western balsam bark beetle. In their service trip report, Angwin and Raimo (1992) recommended that a comprehensive vegetation management plan be developed, and that a detailed assessment of the health of the forest stands be included. As a result, Forest Health Management personnel at the Gunnison Service Center were requested to conduct an extensive survey to identify the location, distribution, and severity of insect and disease conditions at the ski area. An aerial survey flown in July 1993 was followed by a ground survey in August 1994. The following biological evaluation details the findings of the two surveys.

METHODS

Aerial Survey

On July 31, 1993, an aerial photo mission was flown by Dick Myhre of the Forest Pest Management Methods Application Group. The flight covered Aspen Mountain, Aspen Highlands, and Tiehack/Buttermilk ski areas. Thirty-five overlapping photos, along four north/south-oriented flight lines covered Aspen Mountain. The photos ranged in scale from approximately 1:8,000 (over high-elevation terrain) to 1:12,000 (over low-elevation terrain). In order to enhance the visibility of dead and dying trees, color infrared film was used. Following receipt of the infrared survey photos, stand locations and cover types were delineated within the ski area boundaries. Dead and dying coniferous trees (presumably affected by root disease or bark beetles) were then identified on the infrared photos by looking for individual and groups of white-to-cream-colored trees within the stands of normal, healthy red-colored trees.

Ground Survey

During the week of August 7, 1994, the individual and groups of off-colored trees on the infrared photos were located and inspected. Whenever possible, the cause of death or discoloration of dead or dying trees was determined. Trees with yellowing, red, or thinning crowns were checked for root disease by excavating at least two roots and looking under the bark for signs of disease-causing fungi. Bark beetle activity was identified by looking for exit holes, pitching, and frass on fading trees, while the species of bark beetles affecting the trees were identified by inspection of gallery patterns underneath the bark and by the morphology of beetles found within the galleries. Other insect and disease conditions were noted as observed.

RESULTS

After accounting for photo overlap, a total of 36 spruce/fir stands were identified within the ski area boundary that contained dead or dying trees. Most of these stands were located on the upper half of the mountain. The locations of the stands are shown in Appendix A. The stands were subsequently visited and assessed for root disease and bark beetles. The results of the ground survey are summarized in Appendix B. All of the stands that were visited were spruce/fir cover type, though many contained significant numbers of lodgepole pine, Douglas-fir, or aspen. Following are descriptions of the major insect and disease situations that were encountered.

Root Disease

Root disease symptoms (patches of dead and dying trees, trees broken from the roots or at the root collar, trees with thin or yellow crowns) were noted in all but three of the stands. In almost all of the stands, symptoms were restricted to subalpine firs. In twenty of the stands, conclusive evidence of Armillaria root disease (white mycelial fans and/or rhizomorphs under the bark of the roots) was found. Except for two down, dead Engelmann spruce in Stands 1 and 9, Armillaria sp. was identified only on subalpine fir.

Bark Beetles

Bark beetle exit holes, frass, and/or beetle-induced pitching was identified in dead and dying subalpine firs in all but four of the inspected stands. In all cases, star-shaped galleries characteristic of the western balsam bark beetle (Dryocoetes confusus) and/or the beetles themselves were readily identified. The relationship between Armillaria root disease and western balsam bark beetle is well known. The usual chain of events starts when Armillaria, present at low levels in the stand (and causing little damage) increases due to disturbance or drought stress. Next, Dryocoetes populations build up in the weakened trees, and the effects of the two agents combine to kill the host trees. In addition, beetle populations often build up to the point that additional trees outside the root disease centers are also attacked and killed.

Other Insects and Diseases

A number of other insect and disease conditions were noted in the stands that were visited. Spruce broom rust (Chrysomyxa arctostaphyli) was found on Engelmann spruce in several stands. Twig beetles (Pityophthorus sp.) was identified in subalpine fir in three stands. Mechanical wounding by skiers and heavy equipment, as well as damage caused by animals (porcupine or squirrel) was also observed in several stands. Winter drying of conifers and sunscald of aspen were noted in two stands. Although aspen is particularly susceptible to a number of insect and disease conditions, the aspen stands that were seen during the course of the ground survey were in relatively good condition.

MANAGEMENT ALTERNATIVES

1. Do Nothing. Under this alternative, mortality of the subalpine fir due to Armillaria root disease will continue. Current disease centers will continue to expand and new ones will appear. Although underground root disease spread is relatively slow, expansion of the root disease centers may proceed at a rate of approximately 1-2 feet per year. Within the root disease centers, regeneration of subalpine fir will be severely limited. New mortality will be particularly evident during years of drought. Additional mortality may also occur as populations of western balsam bark beetle build up in the root-diseased trees and spread to adjacent healthy firs. Without active management of the root disease/bark beetle situation and replacement with more disease-resistant spruce, affected stands will continue to decline. This will result in increased hazard potential and severely impact the aesthetic quality of the top half of Aspen Mountain.

2. Reduce Tree Hazard Potential. This alternative involves the implementation of a program of annual inspections to detect, identify, and remove hazard trees. The tree hazard evaluation proposed is best accomplished in three steps: identification, documentation, and corrective action. The evaluation is not merely a checkup of tree mortality; identification of hazard trees entails the evaluation of both the probability of failure (tree defect evaluation) and the probability of injury or damage (target evaluation). Not all defective trees need to be removed; only those whose proximity to a target (such as lift lines, permanent structures, etc.) is such that the risk the tree poses outweighs the benefits it provides. In order to reduce liability, complete documentation of all hazard tree inspections is a necessity. An appropriate hazard tree assessment system for campgrounds has been developed by Johnson (1981). This system may be adapted for use at the ski area. In addition, a videotape by Sharon and Steinke (1989), "Tree Health Management: Evaluating Trees For Hazard," is available to help train inspection personnel.

3. Implement Root Disease/Bark Beetle Management. Under this alternative, steps will be taken to alleviate the root disease and bark beetle situation in the spruce/fir stands. The most effective way to manage the root disease/bark beetle complex is to concentrate efforts on the fungal root disease pathogen. Removal of the dead and dying subalpine firs and planting or favoring more tolerant spruce and aspen in subsequent regeneration efforts is recommended.

Armillaria root disease spreads from tree to tree along root-root contacts, and diseased trees often take many years to show above-ground symptoms. Because of this, it may be assumed that many healthy-looking subalpine firs within 30-50 feet of visibly-infected trees and stumps are also infected by the fungus. To address the problem of non-symptomatic infected trees, removal of all host trees within a 30-50 foot buffer zone around visibly infected trees is often recommended. However, at Aspen Mountain, the root disease centers are so widespread that installation of buffer zones would be aesthetically unacceptable.

Because Armillaria has the ability to survive for decades in infected stumps, it is often recommended that the stumps be removed from the ground. However, under the above management scenario, the fungus will likely remain in infected, though tolerant, standing spruce, aspen, and Douglas-fir. Because of this, stump removal to cleanse the stands of the fungus is not recommended.

As stated previously, the relationship between Armillaria and the western balsam bark beetle is well known. Because beetle populations may build up in fresh downed material, prompt removal of any firs that are cut will be needed. Trees that are cut from late spring to late fall should be removed within six weeks. Those that are cut from late fall to winter may remain until the following spring.

Although spruce, aspen, Douglas-fir, and older lodgepole pine (more than 25-years old) are also susceptible to Armillaria root disease, they appear to be more tolerant of the disease and may thus be retained within the disease centers. Regeneration of these species (particularly spruce) should be encouraged. Aspen, however, should only be favored in areas where they will not be hazardous when fully grown. Fencing of heavily trafficked areas and/or the installation of signs to discourage glade skiing may be necessary to protect the new regeneration.

If difficulties are encountered with natural regeneration, active planting should be considered. If possible, planting of larger trees (5-15-feet tall) is recommended over smaller seedlings. Suitable planting stock may be obtained commercially or from the stands within or immediately adjacent to the ski area. Trees obtained from the latter source may be transplanted by the use of a tree spade and should be taken no closer than 50 feet from a visibly root diseased tree. Trees that meet this criterion are quite abundant on Aspen Mountain. When using a tree spade, at least 10 inches of root ball radius is needed for each inch of tree diameter, as measured at the base. Intensive watering of the new transplants is critical. Again, where animal damage is noted, or where skier traffic is great, fencing may need to be considered to protect the new transplants.

4. Promote Age and Species-Class Diversity. Overall, the pest problems observed on Aspen Mountain are typical of mature, non-managed stands. To minimize the impacts of these pests in the future, vegetation management efforts need to concentrate on the gradual replacement of older stands by younger, more vigorous stands. This can be accomplished by the application of a series of thinning and regeneration cuts throughout the mountain. In most stands, over one-third of the stems may be removed without causing detrimental aesthetic impact. Treatments designed to address specific pest situations should be integrated into this overall vegetation improvement effort. In the spruce/fir stands, older subalpine fir and diseased or damaged trees of all species may be discriminated against. In contrast, because of its durability and longevity, most of the spruce should be retained. On the lower half of the mountain and on drier, more exposed sites, Douglas-fir and lodgepole pine may be favored. Where aspen is present, small patch cuts may be done to encourage new sprouting of decadent stands. Again, fencing may be needed to protect regeneration from glade skiers.

An additional way to introduce younger vegetation on the mountain is by the creation of "dynamic leave strips". This is accomplished by cutting a vertical section of trees along one side of a stand while fencing an identical section on the opposite side of the stand. In this way, new regeneration may come up in the fenced section to replace the section that was removed. If a number of these treatments are done through the years in a planned, systematic way, additional healthy vegetation may be constantly cycled in. Again, this treatment may be coordinated with the root disease/bark beetle treatments. Stands 5, 12, 13 and 18 are examples of stands where the installation of dynamic leave strips may be particularly appropriate.

Management of the aspen stands at Aspen Mountain Ski Area should not be neglected as attention is focused on the coniferous stands. While most of the aspen is in relatively good shape, as these stands grow older, more intensive management will be required. Deteriorating aspen clones exhibiting butt rot, stem decay, or cankers may be clearcut in small patches and sprout-regenerated.

5. A Combination of Alternatives 2, 3, and 4. The above alternatives are not mutually exclusive. They are best used in combination to solve specific problems in many areas.

RECOMMENDATIONS

- Institute an annual hazard tree evaluation and removal program.

- Promote stand age and species-class diversity.

- Implement root disease/bark beetle management.

- Explore and implement interpretive opportunities in association with stand management.

- Complete and implement a Vegetation Management Plan.

In a developed recreation setting, such as at Aspen Mountain Ski Resort, a major objective of vegetation management is to create and perpetuate a healthy, diverse forest which is visually pleasing, minimizes tree hazard, and is less prone to damage by insects and disease. The best way to achieve this goal is by applying a variety of management activities to address hazard tree, insect, and disease situations. Management Alternative 5 is therefore recommended.

Because of the extremely high year-round visitorship on the mountain, the management of potential tree hazards needs to be a top priority. Although very few tree hazard situations were noted during the survey, an annual hazard tree inspection program needs to be maintained in order to keep up with the problem. Included in the program should be the identification and immediate removal of dead, dying, and highly defective trees within falling distance of permanent structures, lift lines and human congregation points, as well as complete documentation of all inspection activities. The Forest Health Management specialists at the Gunnison Service Center are available to provide guidance in

the implementation of the hazard tree program and to train ski area personnel in the recognition of potentially hazardous trees.

As stated above, thinning, regeneration, and dynamic leave strip cuts are key to the creation and maintenance of a more vigorous, healthy forest on Aspen Mountain. Years of fire exclusion and lack of intensive management have resulted in conditions that favor the proliferation of insects and diseases. Stress brought on by drought conditions of the last 6-7 years (this year excepted) has resulted in the rapid appearance of Armillaria root disease and western balsam bark beetle. Adoption of the measures to promote age and species-class diversity described in Management Alternative #4 is strongly recommended, even where insect and disease problems are currently minimal. Again, treatments designed to address specific pest situations may be integrated into this overall vegetation improvement effort.

Unless specific steps are taken to address the root disease/bark beetle situation, firs will continue to be lost at an increasing rate. Site-specific management recommendations to address the root disease/bark beetle situations are given in Appendix B. Because the removals, regeneration, and replanting will take many years to complete, treatment of the stands on the mountain will need to be prioritized. Visual impact is recommended as the best criterion on which to prioritize the treatments. Stands that are highly visible from the restaurants, ski lifts, gondola, or surrounding ski runs should be treated first. Stands 15, 16, 17, 19, 20, 28, and 29 are examples of highly visible stands that should be given high priority. Whenever planting is done in areas where moderate-to-high animal damage is present, (such as Stands 15 and 21), consideration may also need to be given to installing protective fencing around individual trees.

In order to be sure that the treatments have been effective, continued monitoring of the stands will be necessary. Because buffer zones will not be installed in the initial round of treatments, many trees will be left that do not yet show symptoms of root disease, and additional ones will likely be attacked by the western balsam bark beetle. Additional removals (followed by regeneration and/or planting) will thus be needed as more mortality appears.

Appendix B also gives recommendations to address several of the other insect and disease situations that were encountered while performing the survey. Twig beetle (Pityophthorus sp.) seldom causes major damage and need not be given management consideration. Spruce broom rust generally causes only minor damage, but large brooms can provide entryways for decay-causing fungi. Removal of rust-infected spruce during the thinning operations can reduce this potential problem. However, where spruce stocking levels are low, infected trees may be retained. Trees that have high degrees of animal or mechanical damage are also prone to decay. Again, where stocking allows, these damaged trees may also be discriminated against during thinning.

Throughout the thinning and insect/disease sanitation operations, great care will need to be taken to avoid damaging residual trees and established regeneration. Wounds that are inflicted during management

operations may provide entry courts for decay-causing fungi and cause additional losses in the future. To give the greatest degree of control during cutting, trees should be directionally felled at a 45-degree upslope angle, working from the top of the slope to the bottom. To avoid further damage to the residuals, some trees may need to be bucked on site prior to removal.

To give the public a greater understanding of the vegetation management activities at Aspen Mountain, we further recommend that opportunities for interpretation be explored and exploited. Placement of signs on the mountain, or the installation of a series of interpretive signs along one of the more highly-used ski trails (an interpretive ski run), may be used to generate public awareness of what is being done by the Forest Service and the Aspen Skiing Company to enhance forest health in the area. Signs along hiking and mountain bike trails may, in turn, convey the message to summer-time users. Specific treatments may be explained and the efforts to enhance the long-term vegetative character of the area may be highlighted. The message that the forest is a dynamic, changing ecosystem, not a static, fixed one, may also be conveyed. Through these efforts, public support for the vegetative treatments may be generated. Additional signs may also encourage visitors to help in the overall effort by staying out of newly planted or regenerated areas and to refrain from damaging the trees. Public involvement from local or visiting groups in any replanting efforts that are carried out may also be solicited and encouraged. As always, the Forest Health Management Staff of the Gunnison Service Center is available to assist with the interpretive effort.

In order that the suggested insect/disease treatments and interpretive efforts be coordinated with the other land management objectives for the area (aesthetic, recreation, wildlife, and other concerns), the vegetation management plan that is currently being developed should be completed as soon as possible. Again, the staff of the Gunnison Service Center is available to assist with the development of the management plan. In addition, vegetation management plans from other ski areas (Crested Butte and Winter Park) are available on request.

LITERATURE CITED

Angwin, P.A. and B.J. Raimo. 1992. Aspen Mountain Ski Area service trip report. USDA For. Serv., Renewable Resources, Letter to White River NF Forest Supervisor, File Desig. 3400, Nov. 6, 1992. 5p.

Johnson, D.W. 1981. Tree hazards - recognition and reduction in recreation sites. USDA For. Serv., Timber, For. Pest, and Coop. For. Mgmt. Tech Rep. R2-1. 17p.

Sharon, E.M. and D. Steinke. 1989. Tree health management: evaluating trees for hazard. VHS Video. Dist. by the Am. For. Assn. and the Int. Soc. of Arboriculture. 39 min.

APPENDIX A

Locations of surveyed stands
at Aspen Mountain Ski Resort,
Aspen Ranger District,
White River National Forest.

Sun Deck

Bonnie's

Bell Mountain

Lift G

Buttfills

Ruttin's

Silver Queen Gondola

Lift 1-A

Little Nell

Maintenance

Aspen

Key

- Ski Area Boundary
- Ski Lift Location
- Road
- Veg. Stand / Site
- Stream
- Building
- (21) Ground-surveyed Veg. Stand/Site

Draft Map 5·11·
USFS
By: Renee Brick

APPENDIX B

Tree disease conditions and vegetation management recommendations at Aspen Mountain Ski Resort, Aspen Ranger District, White River National Forest.

TREE DISEASE CONDITIONS AND MANAGEMENT RECOMMENDATIONS IN SELECTED STANDS AT ASPEN MOUNTAIN SKI RESORT

STAND #	DOMINANT TREE SPECIES	ROOT DISEASE SYMPTOMS	POSITIVE ID OF ARMILLARIA	POSITIVE ID OF DRYOCOETES	OTHER I/D OR DAMAGES	MANAGEMENT RECOMMENDATIONS
1	S/F	Y-SAF	Y-SAF,ES	Y-SAF	1	1,2,3
2	S/F	Y-SAF	Y-SAF	Y-SAF		1,3
3	S/F	Y-SAF	Y-SAF	Y-SAF		1,3
4	S/F	Y-SAF	N	Y-SAF	1	2
5	S/F	N	N	N		4
6	S/F	Y-SAF	N	Y-SAF		1,3
7	S/F	Y-SAF	N	Y-SAF	1	1,2,3
8	S/F	Y-SAF	Y-SAF	Y-SAF		1,3
9	S/F	Y-SAF	Y-ES	Y-SAF		1,3
10	S/F	N	N	N	2	0
11	S/F	Y-SAF	Y-SAF	Y-SAF		1,3
12	S/F	Y-SAF	Y-SAF	Y-SAF		1,3,4
13	S/F	Y-SAF	Y-SAF	Y-SAF		1,3,4
14	S/F, SOME A	Y-SAF	N	Y-SAF		1,3,5
15	S/F	Y-SAF	Y-SAF	Y-SAF	2,3	1,3,6
16	S/F	Y-SAF	Y-SAF	Y-SAF		1,3
17	S/F	Y-SAF	Y-SAF	Y-SAF		1,3
18	S/F	Y-SAF	N	Y-SAF		1,3,4
19	S/F, SOME LPP	Y-SAF	N	Y-SAF		1,3
20	S/F	Y-SAF	N	Y-SAF		1,3
21	S/F	Y-SAF	Y-SAF	Y-SAF	3	1,3,6
22	S/F, SOME A, LPP	Y-SAF	N	Y-SAF		1,3,5
23	S/F, A	Y-SAF	N	N		1,5
24	S/F, SOME LPP	Y-SAF	Y-SAF	Y-SAF		1,3,7
25	S/F, SOME LPP	Y-SAF	N	Y-SAF		1,3,7
26	S/F	Y-SAF	Y-SAF	Y-SAF		1,8
27	S/F, A, LPP, DF	Y-SAF	Y-SAF	Y-SAF		1,8,9
28	S/F, A	Y-SAF	Y-SAF	Y-SAF		1,10,5,8
29	S/F, A	Y-SAF	Y-SAF	Y-SAF		1,10,5,8
30	S/F	N	N	N	4	0
31	S/F	Y-SAF	N	Y-SAF		1,3
32	S/F	Y-SAF	N	Y-SAF		1,3
33	S/F, A, LPP	Y-SAF	Y-SAF	Y-SAF	2,4,5	1,11,5,8
34	S/F, SOME A, LPP	Y-SAF	N	Y-SAF		1,12,5,8
35	S/F, A, DF	Y-SAF	Y-SAF	Y-SAF	6	1,5,3,13
36	S/F, A, DF, SOME LPP	Y-SAF	Y-SAF	Y-SAF	3	1,11,12,5,8

TREE DISEASE CONDITIONS AND MANAGEMENT RECOMMENDATIONS IN SELECTED STANDS AT ASPEN MOUNTAIN SKI RESORT (Cont.)

LEGEND

STAND #- Stand numbers correspond to site designations shown in Appendix A.

DOMINANT TREE SPECIES-
- S/F = Mix of Engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa)
- LPP = Lodgepole pine (Pinus contorta)
- DF = Douglas-fir (Pseudotsuga menziesii)
- A = Aspen (Populus tremuloides)

ROOT DISEASE SYMPTOMS-
- Y = Presence of individual and groups of dead and dying trees, indicative of root disease. Additional symptoms include resinosus and whole-tree chlorosis (not individual branches).
- N = Root disease symptoms not found
- SAF = Root disease symptoms noted on subalpine fir

POSITIVE ID OF ARMILLARIA-
- Y = Armillaria root disease (Armillaria sp.) positively identified by the presence of rhizomorphs or mycelial fans on roots of symptomatic trees
- N = Signs of Armillaria root disease not found
- SAF = Root disease identified on subalpine fir
- ES = Root disease identified on down, dead Engelmann spruce

POSITIVE ID OF DRYOCOETES-
- Y = Galleries of western balsam bark beetle (Dryocoetes confusus) identified on subalpine fir
- N = Galleries of western balsam bark beetle not found

OTHER I/D OR DAMAGES-
1. = Spruce broom rust (Chrysomyxa arctostaphyli) on Engelmann spruce
2. = Twig beetle (Pityophthorus sp.)
3. = Animal damage (porcupine or squirrel)
4. = Mechanical wounding
5. = Winter burn of conifers
6. = Aspen sunscald

TREE DISEASE CONDITIONS AND MANAGEMENT RECOMMENDATIONS IN SELECTED STANDS AT ASPEN MOUNTAIN SKI RESORT (Cont.)

MANAGEMENT RECOMMENDATIONS- Note: In ALL stands, removal of high hazard trees (ie., dead snags within falling distance of permanent structures or highly used roads or ski runs) should be made a high priority. Hazard tree inspections and removals should be made every year, prior to the start of ski season. Also- wherever cutting is performed, measures should be taken to protect regeneration and/or planted trees. This may be accomplished by leaving some cut trees on the site (where safety permits) or by installing fences to keep skiers out.

0 = No silvicultural treatments necessary at this time.
1 = Remove dead and fading (bark beetle and root disease-infected) subalpine fir.
2 = Discriminate against spruce with broom rust during thinning operations.
3 = Underplant with spruce (large tree spade stock is recommended).
4 = Consider installation of dynamic leave strips (Remove all trees along one side of the stand and plant along the opposite side. Install fences to protect the newly planted areas. If the stand is too narrow to cut, plant along one side in anticipation of future removals on the opposite side).
5 = Allow aspen to regenerate.
6 = Protect planted trees from animal damage.
7 = Underplant with lodgepole pine (large tree spade stock is recommended).
8 = Do not underplant- allow natural regeneration of conifers.
9 = Patch clearcut and regenerate aspen.
10 = Remove additional subalpine fir in small patches around root disease centers (approx. 1/2-tree length in diameter) to allow adequate regeneration.
11 = Remove mechanically wounded and/or animal-damaged trees.
12 = Thin the entire stand. Remove at least 1/3 of trees from all age classes. Discriminate against subalpine fir and diseased or defective trees.
13 = Underplant with Douglas-fir (large tree spade stock is recommended).

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